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Insights & Innovation from CyberOptics Semiconductor

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<http://www.cyberopticssemi.com/contact/device/>

Breaking Metrology News . . .

CyberOptics Releases Latest Vibration-Monitoring Software for Wafer Processing Equipment

Software Filters Out Accepted Vibration Frequencies in a Process to Identify Anomalies

Engineers from CyberOptics Semiconductor released their latest vibration-monitoring software at this year's SEMICON Taiwan and demonstrated how it helps engineers predict equipment failure and identify wafer-contamination sources to improve yield and cycle time.

CyberOptics' team demonstrated how engineers identify vibration anomalies by filtering out acceptable acceleration offsets produced by regular slow-moving equipment or high-frequency noises between 1 to 200 Hz, according to Craig C. Ramsey, Ph.D., CyberOptics Semiconductor's general manager and CTO.

Ramsey said engineers are able to set low, high or band-pass filters of equipment vibration frequencies with the company's latest vibration-monitoring software. Engineers may, for instance, filter out vibrations of 20 Hz and below and monitor vibrations of 21 Hz and above.

The software gives engineers the ability to troubleshoot and conduct preventative maintenance (PM) for vibration-related contamination and downtime "more efficiently and accurately by accounting for the natural environment of each process and existing controls," Ramsey said.

"When you know the relationship between equipment and tools in a process, you can really begin to optimize for acceleration and vibration," Ramsey said. "Our team walked engineers through vibration monitoring and how the data applies to the floor."

Ramsey added that CyberOptics' new AVS 1.6 for the WaferSense® Auto Vibration System (AVS) helps engineers "quickly contrast" vibration by equipment, run time and technician to set process controls. The software allows engineers to generate an overview CSV file in Excel that contains a color-coded summary table of peak accelerations and vibration excursion across multiple data log files.

Fab engineers analyze more narrow data with the software by comparing two waveforms from different data logs. Engineers lay a second log-file trace for time domain and frequency domain

over the main trace. Users can also export a portion of a single data log to a CSV file, as well as an entire data log.

Engineers have the ability to select from one of three units of measurement when using the software: g-Force, GAL (acceleration in cm/s^2) -- or Energy (g^2sec), which is a “good indicator of how much vibration a piece of equipment experiences in a given period,” Ramsey said.

CyberOptics’ AVS is a wireless, wafer-like device that allows engineers to establish yield-based vibration standards for equipment and technicians, identify vibration sources and set acceptable acceleration parameters for equipment.

CyberOptics Semiconductor demonstrated its set of vibration-monitoring applications, VibeView™ and VibeReview™, and its entire line of WaferSense metrology devices with its distribution partner in the region, Taiwan Puritic Corp. (TPC).

For more details on the software and download instructions, visit <http://www.cyberopticssemi.com/downloads/wafersense/avs/>

The WaferSense family of devices includes the Airborne Particle Sensor (APS), Auto Leveling System (ALS2), Auto Teaching System (ATS) and Auto Gapping System (AGS). Each device follows the processing life of a wafer and reports real-time metrology data.

>> WaferSense® Auto Vibration System (AVS):

<http://www.cyberopticssemi.com/products/wafersense/avs/>

>> WaferSense® metrology devices:

<http://www.cyberopticssemi.com/products/wafersense/>

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CyberOptics CTO Details Effects of Gap Measurement on Film Production at ISMI Symposium on Manufacturing Effectiveness

Wireless Method Increases Fab’s First Pass Film Checks by 24% Over Legacy Method

Leaders of the chip making industry at this year’s ISMI Symposium on Manufacturing Effectiveness examined how engineers used a wireless method to measure the gap between a plasma-enhanced chemical vapor deposition (PECVD) heater and showerhead and improved first pass film checks by 24% during a session on equipment productivity with the CTO of CyberOptics Semiconductor, Craig C. Ramsey, Ph.D.

At the 6th annual symposium, which offered attendees information to reduce manufacturing expenses and increase productivity, Ramsey addressed how engineers control gap uniformity and magnitude with high stability over time. He contrasted a legacy gap-measurement method used by engineers that employs a wired leveling device and crush blocks with a method that employs a wireless gapping device and NIST traceable gap field standard.

Ramsey detailed how the legacy method led to lower first pass film checks -- with 20% of chambers failing film checks -- and lower chamber availability, as well as increased maintenance cycle time and expenses. Ramsey added that the legacy method isn't a repeatable process and doesn't yield reproducible data. Measurements obtained by the wired leveling device and crush blocks are susceptible to instrument and operator variances.

Engineers often repeat the legacy gapping process multiple times before a chamber comes within the gap tolerances required to deposit quality films, according to Ramsey. The films are then deposited onto monitor wafers and the average thickness and thickness uniformity are measured to ensure that films are within specification.

"And when films fail the parametric check with the legacy method, the gapping process must be repeated and six hours of chamber production time is lost," Ramsey said. "When you walk through the steps of the legacy gapping method, you really see the extra work and challenges the instruments present."

Ramsey's presentation, titled "Improved Film Production in a High-Volume Fab," detailed how engineers increased the first pass film-check rate from 80% to over 99%, as well as chamber availability by 4% using the wireless gap-measurement method. The wireless method is repeatable and gives engineers data to optimize their preventive maintenance (PM) schedules and process controls, according to Ramsey.

The wireless device used by engineers, the WaferSense® Auto Gapping System (AGS), contains three non-contact distance sensors that return gap measurements in real time to a laptop or PC in numerical and graphical form. Engineers used the device to ensure gaps were accurate and uniform to allow for enough film at the proper thickness. The vacuum-compatible device also minimized the possibility of chamber contamination and shortened the total tool maintenance cycle.

"Average film-thickness variation was maintained within specification with the wireless gap-measurement method," Ramsey said. "And the fab experienced improved film production."

The AGS' parallelism accuracy is 0.025 mm (± 0.001 "), and its gap accuracy is 0.025 mm (± 0.001 ") with a gap of 15 mm (0.600"). The AGS is available in 200 and 300 mm form factors, with the AGS300 being the best-known method (BKM) -- for 40% improvement in film uniformity -- for gapping Novellus VECTOR® tool chambers.

>> WaferSense® Auto Gapping System (AGS):

<http://www.cyberopticssemi.com/products/wafersense/ags/>

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CyberOptics Session at AEC/APC Symposium in Asia Lays Out Steps for a Vibration Diagnosis

Semiconductor professionals at this year's AEC/APC Symposium in Asia examined the role of vibration sensors in helping fabs employ the "data-driven and automated decision making"

promoted at the symposium during a poster session by Yukinobu Hayashi, an applications engineer at CyberOptics Semiconductor.

Hayashi's session at the symposium addressed how the collection and analysis of vibration and acceleration data via a wireless sensor is a good example of the industry movement to fab-wide automation and the implementation of advanced equipment and process controls.

Hayashi highlighted the need for engineers to obtain "as much information as possible," including vibration sources, when performing costly and time-consuming equipment maintenance for sensitive processes in compact environments.

"When you vent a vacuum chamber to atmospheric pressure, cool down high-temperature tools and expose clean spaces to fab surroundings, you have a great opportunity to obtain empirical data on vibration," Hayashi said.

Hayashi added that without precise data, engineers aren't able to locate persistent vibration sources and set advanced controls for a process to reduce vibration.

At the symposium, Hayashi detailed how to employ a wafer-like sensor in sensitive processes to conduct a proactive "vibration diagnosis."

He described how engineers use the vacuum-compatible device, the WaferSense® Auto Vibration System (AVS), to obtain precise three-axis (x, y, z) acceleration and vibration data in real-time to identify and correct vibration sources that reduce yield. The device follows the path of a wafer in a process.

For more information on conducting a vibration diagnosis for a specific process or Hayashi's complete poster session at AEC/APC Asia, please contact CSsales@cyberoptics.com.

>> WaferSense® Auto Vibration System (AVS):
<http://www.cyberopticssemi.com/products/wafersense/avs/>

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CyberOptics Demonstrates Metrology Application's Role in Metrics-Based Process Controls at SEMICON Japan

CyberOptics Semiconductor's team at SEMICON Japan demonstrated the role of its vibration-monitoring software in setting metrics-based process controls at fabs.

The CyberOptics team demonstrated how engineers use the software to apply precise data on equipment vibration and acceleration to establish yield-based vibration tolerances and controls for fab processes and technicians.

"We know that at the most efficient fabs in Japan precise metrics-based controls are helping to drive margins, and they'll only become more important at the next-generation fabs being planned," said Yukinobu Hayashi, an applications engineer at CyberOptics Semiconductor. "And,

certainly, software plays a key role in how our industry collects and applies data toward metrics-based standards -- now vibration is an even greater part of the overall equation.”

Hayashi added that the de facto method for measuring the amplitude and frequency of equipment vibration -- listening for noises and visually monitoring wafer movements -- doesn't give engineers the vibration data they need to improve processes.

“Fab managers in Japan facing further automation see equipment vibration as one of their primary metrology concerns,” Hayashi said. “They know vibration is tied to equipment failure, particle contamination and drops in yield and cycle time -- so they're looking for precise metrology data to manage vibration.”

Hayashi and the CyberOptics team showed how engineers identify vibration anomalies with the software by filtering out acceptable acceleration offsets -- produced by regular slow-moving equipment or high-frequency noises between 1 to 200 Hz.

Engineers use the software to set low, high or band-pass filters of equipment vibration frequencies. Engineers may, for instance, filter out vibrations of 20 Hz and below and monitor vibrations of 21 Hz and above.

CyberOptics' latest application, AVS 1.6, works with the wireless WaferSense® Auto Vibration System (AVS) to help engineers quickly contrast vibration by equipment, run time and technician to set process controls. The software, for instance, allows engineers to generate an overview CSV file in Excel that contains a color-coded summary table of peak accelerations and vibration excursion across multiple data log files.

>> WaferSense® Auto Vibration System (AVS):

<http://www.cyberopticssemi.com/products/wafersense/avs/>

>> CyberOptics' Japanese-language Website:

<http://jp.cyberopticssemi.com/>

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Reports from the Fab

Fab Establishes Co-Planarity Across Vertical Diffusion Process to Reduce Wafer Particle Contamination, Improve Yield

The User

A 300 mm fab for one of the world's largest chipmakers.

Multi-Wafer Diffusion Process Calls for Co-Planarity Among Stations

Wafers being processed at a 300 mm fab's vertical diffusion furnace received micro scratches during uneven handling and z-axis movement that led to particle contamination, scrap and

shattered wafers. The lack of co-planarity among the tools and wafers throughout the multi-wafer process reduced yield and led to prolonged equipment and staff downtime to troubleshoot contamination sources.

Wafers in the process traveled, 25 at a time, in a front open unified pod (FOUP) to the robot end effector, which fed five full FOUPs, or 125 wafers, into the wafer boat that transferred them up into the furnace, operating at approximately 1,200° C.

The number of wafers being handled and narrow pitch between wafers in FOUPs and the wafer boat made wafers traveling through the process susceptible to damaging micro scratches if a station in the process wasn't level.

"Every station in the process and wafer position really has to be in line and consistent when you're processing that many wafers in a tight space," said Allyn Jackson, customer supporter manager at CyberOptics Semiconductor.

The long vertical path wafers traveled in the wafer boat, which often became crooked, also made them vulnerable to micro scratches and further damage in the hot furnace, Jackson said.

Engineers ran a batch of test wafers after using tools such as bubble levels and calipers and line-of-sight checks to attempt to establish co-planarity among the FOUPs, robot and wafer boat.

Jackson added that engineers didn't examine the alignment of the wafer boat along the z-axis path as it approached and entered the furnace. Engineers stopped the process for calibration troubleshooting only after finding severe particle contamination and wafer damage coming out of the furnace.

"The legacy leveling method that engineers employed wasn't accurate and really forced them to react to defects after they occurred," Jackson said.

Establishing Co-Planarity Throughout the Diffusion Process

Engineers operating the vertical diffusion furnace loaded a 300 mm form factor metrology sensor to follow a wafer's path through the process.

The wireless inclinometer captured real-time measurements, including inclination, pitch and roll, as it moved from the FOUP to the robot end effector and into the vertical wafer boat.

The device's companion software displayed the metrology data on a GUI that allowed engineers to establish co-planarity among the tools, including the end effector's five blades, wafer handoffs and perpendicularity of the wafer boat's vertical path.

"Engineers loaded the device into the process and quickly saw which stations weren't level and likely particle-contamination sources," Jackson said.

Jackson said that engineers used the vacuum-compatible WaferSense® Auto Leveling System 2 (ALS2) to enter the diffusion furnace, without taking equipment offline, to establish co-planarity among the FOUP, wafer boat and z-axis path for wafers in and out of the furnace.

“You can’t make sure wafers traveling in a diffusion process are truly level without that kind of in-process perspective,” Jackson said.

The Bottom Line

The 300 mm fab used the wafer-like inclinometer to reduce micro scratches, particle contamination and wafer scrap that stemmed from the lack of co-planarity among the FOUPs, robot end effector and wafer boat in the vertical diffusion process.

The co-planarity established throughout the vertical diffusion process by the wireless sensor improved yield and compressed staff and equipment downtime for characterization, preventative maintenance (PM) and calibration troubleshooting. Engineers also used the device to re-calibrate uneven points in the process without taking the entire process offline.

“They identified and corrected any inclination issues before they became a real source of particle contamination and wafer damage,” Jackson said.

Engineers used the vacuum-compatible device to access and measure inclination at hard-to-reach points in the process, including inside crowded FOUPs, precise wafer boat position and inside the furnace.

Jackson added that engineers operating the diffusion furnace used the data to establish yield-based inclination tolerances and standards for each station to establish reproducible process and technician controls.

Engineers used the new empirical controls to prevent micro scratching of wafers and optimize the vertical diffusion process for optimal yield.

Allyn Jackson, customer support manager
ajackson@cyberoptics.com

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Technically Speaking

“Gap Measurement With Repeat Test”

by Hayashi Yukinobu, Applications Engineer, CyberOptics Semiconductor
(as reported to Hayashi by fab managers)

>> visit our online Resources page: <http://www.cyberopticssemi.com/resources/>

Did You Know?

Our Yield Calculator puts a financial value on a single yield percentage point gained and allows you to input an increase in yield – and then calculate the value in revenue of that yield gain.

>> **WaferSense® Yield Calculator:**

http://www.cyberopticssemi.com/products/calculators/calculator_yield.html

Inside CyberOptics Semiconductor

Our customer support and application offices have moved from the west end of Oregon's Silicon Forest to the south end in Wilsonville, Oregon. As always, you can reach us at the shared e-mail boxes for CSsales@cyberoptics.com and CSsupport@cyberoptics.com to ensure that you get consistently fast service. Our people are positioned to support our partners and customers everywhere semiconductors are fabricated.

Where We'll Be Next

SEMICON Korea

<http://www.semiconkorea.org/>

Distribution Partner SESO Co. Ltd.

Booth# 1744

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